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May 23, 1996

"Subscribed and sworn to before me
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(54) Title of the Invention: A Stamper for Injection Molding

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Specification

1. Title of the Invention

A stamper for injection molding.

2. Claims

A stamper for injection molding characterized in that its surface is coated with a substance having a coefficient of thermal conductivity of 7 x 10^{-2} cal/cm.sec.°C or less.

3. Detailed Description of the Invention

<Fields of Industrial Use>

The present invention relates to a stamper used in injection molding of substrates for compact discs, optical memories, etc.

<Summary of the Invention>

The present invention relates to a stamper for injection molding of substrates for compact discs, optical memories, etc., whose surface is coated with a substance having a low coefficient of thermal conductivity of 7 x 10^{-2} cal/cm.sec.°C or less in order to improve the transferability of patterns on the stamper surface such as pits and grooves to the substrate and to improve productivity.

<Prior Art>

Stampers used for injection molding of substrates for use in compact discs, optical memories, etc., are manufactured by first applying a resist to a glass plate and then carrying out laser cutting, followed by conductivizing treatment and nickel electroforming on the order of 300 μ.

After this, the surface is polished and finished to a surface coarseness of 0.1 [illegible], and it is completed to the required dimensions by means of processing of the internal and external diameter. In the past, it was used as is and, in particular, no treatment of the stamper was carried out.

<Problems to be Solved by the Invention>

The stamper described above is installed in a metal mold and used for injection molding, but concerning the pit shape required for the substrate, as the patterns are very fine, with a depth of 0.1 μ, a width of 0.4 μ, and a length of 0.5-2.4 μ in the case of compact discs, and various other specifications in the case of use for optical memories, there were problems with transferability of the pattern on the surface of the stamper to the substrate during injection molding, with it being difficult to control molding conditions, and this has also greatly affected productivity. For this reason, in order to solve the above problems, the present invention aims to improve the transferability of pits or grooves and improve productivity by slowing cooling of the molten resin on the stamper surface.

<Means for Solving Problems>

In order to solve the above problems, the present invention comprises a stamper whose surface is coated with a substance having a low coefficient of thermal conductivity of 7 x 10^{-2} cal/cm.sec.°C or less and in which thermal conductivity between the stamper and the metal mold is reduced.

<Action>

As described above, in the stamper whose surface is coated with a substance having low thermal conductivity, as the heated molten resin shows poor thermal conductivity from the stamper to the metal mold in the case of injection molding on the stamper surface, the rate of cooling of the molten resin is slowed, and particularly in the case of continuous molding, due to contact with the heated molten resin, the surface temperature of the stamper becomes higher than that of the metal mold, lengthening the flow time of the resin on the stamper surface and making it possible to improve transferability and stabilize production.

<Practical Example 1>

After application of a resist to a glass plate, laser cutting, and development processing, nickel electroplating on the order of 300 μ was carried out on a plate having pits 1200 Å in depth formed in it, and surface polishing and internal/external diameter treatment were then carried out to complete a stamper for compact disc use.

A 2 μ film of Al_2O_3 was formed on the surface of this stamper by sputtering (coefficient of thermal conductivity of Al_2O_3: 4 x 10^{-2} cal/cm.sec.°C).

Sputtering conditions

1. Initial pressure reached: 7 x 10^{-7} Torr
2. Sputtering pressure: 5 x 10^{-3} Torr (introduction of Ar)
3. Sputtering rate: 400 Å/min.
4. Sputtering power source type: RF type
5. Sputtering preheating: 80°C, 3-minute retention
6. Target: Grade 3 N, manufactured by Kojundo Kagaku

<Practical Example 2>

A 1 μ SiO_2 film was formed on the surface of the same stamper as in Practical Example 1 (coefficient of thermal conductivity of SiO_2: 4 x 10^{-3} cal/cm.sec.°C)

Sputtering conditions

1. Initial pressure reached: 5 x 10^{-6} Torr
2. Sputtering pressure: 5 x 10^{-3} Torr (introduction of Ar)
3. Sputtering rate: 800 Å/min.
4. Sputtering power source type: RF type
5. Sputtering preheating: 60°C, 5-minute retention
6. Target: Grade 2 N, manufactured by Kojundo Kagaku

<Practical Example 3>

A 0.5 μ TiO_2 film was formed on the surface of the same stamper as in Practical Example 1 (coefficient of thermal conductivity of TiO_2: 2 x 10^{-3} cal/cm.sec.°C)

Sputtering conditions

1. Initial pressure reached: 3 x 10^{-6} Torr
2. Sputtering pressure: 4 x 10^{-3} Torr (introduction of Ar)
3. Sputtering rate: 150 Å/min.
4. Sputtering power source type: RF type
5. Sputtering preheating: 60°C, 5-minute retention
6. Target: Grade 3 N, manufactured by Furuuchi Kagaku

In a comparison of the three stampers prepared in the practical examples described above with a conventional stamper not having a surface coating, mass-production molding was carried out, and the status of pit transfer of the molded substrate was measured using a Taristep [Tr. - Translit] manufactured by Chira-Hobson [Tr. - Translit.] Co.
(Three measurements were conducted in each of four directions for a total of 12 measurements.)

<Sample>	<Pit depth>
1. Substrate molded with stamper of Practical Example 1:	$\bar{x}$ = 1150 Å R = 100 Å
2. Substrate molded with stamper of Practical Example 2:	$\bar{x}$ = 1180 Å R = 80 Å
3. Substrate molded with stamper of Practical Example 3:	$\bar{x}$ = 1130 Å R = 120 Å
4. Substrate molded with a conventional stamper:	$\bar{x}$ = 980 Å R = 300 Å

<Effect of the Invention>

As mentioned above, according to the invention, the surface of a stamper for injection molding is coated with a substance having a low coefficient of thermal conductivity of 7 x 10^{-2} cal/cm.sec.°C or less, thus having the effect of markedly improving the transferability of pits and grooves on the molded substrate compared to conventional untreated stampers.

The stamper material (nickel) has a coefficient of thermal conductivity of approximately 14 x 10^{-2} cal/cm.sec.°C. The results of our experiments showed that in substances having a value close to this, the effect of improving transferability was virtually absent, and a value half this or less is therefore required, with a coefficient of 7 x 10^{-2} cal/cm.sec.°C being specified.

Moreover, in the same manner, the present invention also includes substances and coating methods other than those specified in the practical examples.